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1 European Patent Number: 85905307.6 (117 134)

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Signed this 26th day of March 19 90

Alison Penfold

Description

Plate of inorganic material, process for its production and a use of this plate

The invention relates to a plate of inorganic material, which has a load bearing base layer or consists of such a layer, which base layer is a compressed body of a mixture based on exfoliated vermiculite and binder, which optionally has on one side of the base layer a ceramic covering layer produced by a burning process. The invention further relates to an advantageous process for producing the plate according to the invention, and also to an advantageous use of the plate.

A plate of the type mentioned above is known from US-A-4 122 231. It serves as a water-resistant, moisture-absorbing structural plate, in the production of which a special binder on a silicate and phosphate basis is used which is decisive for the properties of the structural plate. This known structural plate is further provided with a ceramic surface glaze which is applied by a burning process, the duration of which is in the region of 2.5 to 3 min.

It has been established within the framework of the inventive activity that in the case of a plate which has been produced by pressing a mixture of exfoliated vermiculite and a binder, a structural change of the vermiculite texture occurs due to a sufficiently long heat treatment at a sufficiently high temperature, which change results in an increase in the strength and the surface hardness of the vermiculite material.

The invention, as characterised in the claims, first achieves the object of providing a plate of the type mentioned hereinbefore, in the production of which the afore-mentioned structural change of the vermiculite texture is utilised, and also advantageous processes for producing the plate according to the invention and an advantageous use of such a plate.

In accordance with Claim 1, the plate according to the invention is characterised in that in a plate of the type mentioned hereinbefore the base layer is a body which has been heat-treated at temperatures of higher than 800°C, preferably of higher than 900°C, for longer than 3 minutes for the purpose of a structural change of the vermiculite texture.

The technology of the production of plates by pressing a mixture of exfoliated vermiculite and a binder itself is generally known; in particular it is described, for instance, in the introduction to the specification of DE-OS-2 810 132.

The invention will be explained in greater detail below with reference to the Figures:

First of all a first process variant for producing a composite plate is described with reference to Fig. 1, which plate can advantageously be used as a floor tile. Fig. 1 shows this tile in a partial sectional view.

In this process variant, one starts from a support plate which will later form the base layer (1'), for the production of which plate a granulate of exfoliated vermiculite, which was obtained from a raw vermiculite granulate by heating for a short time in an expanding

furnace, is mixed with the aqueous solution of a binder on the basis of an aluminium monophosphate in such a manner that the granulate particles are evenly acted on by the binder. From the granulate thus cemented, which for instance has a binder content of 15% by weight absolute dryness and is additionally pourable and not sticky, a bed of regular thickness is made which is compressed in a suitable unheated prepressing apparatus at a pressure of 50 to 70 N/cm² to 50% of its original bulk volume to form a press cake which can be transported easily. This press cake is then pressed to a bulk density of 900 kg/m³ in a press equipped with a high-frequency capacitor field heating apparatus for the pressed material at a pressure of 80 to 100 N/cm² at a pressed material temperature of about 150 to 180°C for a pressing time of 5 to 10 min, is removed from the press, ground to a thickness of e.g. 10 mm and finally cut into support plate pieces 1 of the desired dimensions.

These support plate pieces 1 are then provided on one side with an intermediate layer 2 of a glass powder frit in a thickness of approximately 0.1 mm. This preferably takes place as is conventional by spraying on the glass powder frit which has been suspended in water and by subsequent drying.

One layer each of a clay granulate which contains 25% by weight glass powder and 5% by weight basalt powder as a flux additive is then applied to these support plate pieces 1, which are provided with intermediate layers 2, in a tile press, and then the entire object is pressed at approximately 300 N/cm² to produce a raw composite plate which then consists of the support plate piece 1, the intermediate layer 2 and a compact clay layer 3 of a thickness of about 2.5 mm which adheres to said layer.

After they have been optionally provided with a glaze layer 4 on the clay layer 3, these raw composite plates are then heat-treated in a baking oven similarly to when baking ceramic tiles. During this heat treatment, in which after a fairly long heating-up period the raw composite plates are kept for about 30 min at a temperature of approximately 1000°C and the plates are then cooled slowly, a structural change which results in an increase in the strength and surface hardness of the vermiculite plate material takes place in the vermiculite plates which serve as support plates, while the applied clay layer 3 and the glaze 4 are ceramised as in a conventional baking process.

The support plate 1 which is converted into a base layer 1' of the composite plate upon the afore-mentioned structural change forms the heat-insulating layer in the composite plate, while the burnt clay layer 3' forms a mechanically protective layer which has a hardness greater than the support layer 1'.

When manufacturing the vermiculite plates, apart from aluminium monophosphate, sodium metaphosphate, e.g. with a proportion by weight in each case of 8% absolute dryness of the overall weight of the cemented granulate, may also advantageously be used as a binder.

In another process variant for the manufacture of a plate according to the invention in the form of a composite plate with a mechanically protective layer, first of all - as described with reference to Fig. 1 - a press cake is made from cemented vermiculite granulate by pre-compressing in the cold state. A clay granulate - of the same composition as in the process variant described above

- is then scattered on to this press cake in an even thickness and the raw composite structure thus produced is pressed to a raw composite plate in a press equipped with a high-frequency capacitor field heating apparatus for the pressed material at a pressure of 80 to 100 N/cm² and a pressed material temperature of 150 to 170°C for a pressing time of 8 to 10 min. This raw composite plate is then divided into plate pieces by saw-cuts to the desired dimensions, which pieces - optionally after the application of a glaze layer to the clay layer - are then converted into a composite plate by heat treatment in a baking furnace, which plate may advantageously be used as a floor tile.

The plate according to the invention may also be produced without a mechanically protective layer. Fig. 2 shows a partial view in section of such a plate, which may advantageously be used as a cladding plate with reduced sound reflection in or on buildings for cladding ceilings or walls.

For manufacturing such a cladding plate, one starts with for instance a vermiculite plate having a thickness of e.g. 20 mm, which is manufactured similarly to the support plate 5 according to Fig. 1. Then grooves 6 are milled into one surface of the vermiculite plate (see Fig. 2) in order to form a relief-like surface structure, and the vermiculite plate is then divided into plate pieces 5 which then - similarly to what is described with reference to Fig. 1 - are subjected to heat treatment at approximately 1000°C, during which treatment the structural change already mentioned in the description of Fig. 1 takes place in the vermiculite material and the plate pieces 5 are converted into the cladding plates 5' which are ready for use.

This cladding plate may also be produced glazed or with a surface glass powder frit layer. Fig. 3 shows this variant in a partial sectional view. For this purpose the grooved plate pieces 5 are glazed and then baked, with the afore-mentioned structural change of the vermiculite material taking place upon this baking, or the plate 5' which itself is already finished may be glazed and subjected to subsequent glaze baking.

Instead of the conventional ceramic glazes 4, a glass powder frit layer may also be applied, which, after the heat treatment or the glaze baking, becomes transparent or - dyed by pigments - is opaque. In this case, a plurality of different glass powder frit layers may also be applied one over the other.

Further variants of the cladding plate are illustrated in Figures 4 and 5, each in partial views in section.

In the variant of Fig. 4, the vermiculite plate 7 provided with a glaze 4 has an irregularly undulating surface structure on the upper side 8. This surface structure is achieved during the production of the vermiculite plate 7 when pressing and curing the vermiculite plate by corresponding shaping of the adjoining press plate.

Fig. 5 illustrates a variant of a cladding plate, in the production of which one starts with a vermiculite plate 9 having a relatively rough surface which is provided on the upper side with a glass powder frit layer 10. After the heat treatment, a mixing zone is formed from surface granular vermiculite material and the frit material, and a granular, porous surface structure is produced on the coated plate side 11.

The cladding plates described with reference to Figures 2 and 5 are preferably laid in a mortar bed, but are alternatively laid by bonding.

The plate provided with the mechanical ceramic protective layer may advantageously be used as a floor tile. Plates without such a mechanically protective layer may advantageously be used as cladding plates with reduced sound reflection in or on buildings for cladding ceilings and walls.

CLAIMS:

1. Plate of inorganic material, which has a load bearing base layer or consists of such a layer, which base layer is a compressed body of a mixture based on exfoliated vermiculite and binder, which optionally has on one side of the base layer a ceramic covering layer produced by a baking process, characterised in that the base layer is a body which has been heat-treated at temperatures of higher than 800°C, preferably of higher than 900°C, for longer than 3 minutes for the purpose of a structural change of the vermiculite texture.

2. Plate according to Claim 1, characterised in that the material of the base layer (1') has a density between 700 and 1400 kg/m^3.

3. Plate according to Claim 1 or 2, characterised in that the proportion of binder in the base layer (1') is between 5 and 20% by weight.

4. Plate according to one of Claims 1 to 3, characterised in that the binder is one based on an aluminium monophosphate and/or inorganic polymeric phosphate, optionally alkali polymeric phosphate.

5. Plate according to one of Claims 1 to 4, characterised in that the ceramic covering layer on the plate surface is or comprises a ceramic glaze (4) or a glass powder frit layer.

6. Plate according to one of Claims 1 to 5, characterised in that the plate has on at least one side a surface structure and/or a surface formed in a relief-like manner.

7. Plate according to one of Claims 1 to 6, characterised in that a mechanically protective layer (3') of ceramic material is arranged on at least one side of the base layer (1').

8. Plate according to Claim 7, characterised in that the mechanically protective layer (3') is one based on burnt clay.

9. Plate according to Claim 7 or 8, characterised in that an intermediate layer (2) based on a glass powder frit is arranged between the base layer (1') and the mechanically protective layer (3').

10. Plate according to one of Claims 7 to 9, characterised in that the mechanically protective layer (3') based on burnt clay has an additive of a flux effective at baking temperatures of 900 to 1100°C.

11. Plate according to Claim 10, characterised in that glass powder and optionally basalt powder is contained as flux additive in the ceramic mechanically protective layer (3').

12. Plate according to Claim 10 or 11, characterised in that the amount of glass powder in the ceramic mechanically protective layer (3') is between 3 and 35% by weight and the amount of basalt powder is between 0 and 15% by weight.

13. Plate according to one of Claims 7 to 12, characterised in that one or more ceramic glaze layers (4) are applied to the ceramic mechanically protective layer (3').

14. Process for the production of a plate of inorganic material, in which for the production of a base layer (1') an exfoliated vermiculite granulate mixed with a binder is compressed and consolidated at elevated temperature to a layer with a bulk density of higher than 700 kg/m^3, during which or after which a ceramic layer is optionally formed by a baking process on at least one of the front faces of the plate, characterised in that the compression to a bulk density between 700 and 1500 kg/m^3 takes place and that the compressed and optionally consolidated layer is heat-treated at temperatures of higher than 800°C,

preferably of higher than 900°C, for longer than 3 minutes for the purpose of a structural change of the vermiculite texture.

15. Process according to Claim 14, characterised in that for production [of] the base layer (1'), there are first produced by compressing and hardening the exfoliated vermiculite mixed with a binder support plates (1,5,7,9), which are optionally ground to a thickness and/or are provided with an optionally relief-like surface structure, that optionally these plates are brought by dividing into the predetermined plate format, and that the support plate (1,5,7,9) is heat-treated at temperatures of higher than 800°C, during which or thereafter optionally a ceramic layer is formed on at least one of the front faces of the plate.

16. Process according to Claim 15, characterised in that to at least one of the front sides of the support plate (1) there is applied an intermediate layer (2) in the form of a glass powder frit and on this a layer of clay (3) containing a flux and/or optionally other additives is applied, and that the resulting raw composite plate is heat-treated at temperatures of higher than 800°C, especially of higher than 900°C.

17. Process according to Claim 16, characterised in that the clay layer (3) of a thickness in the range between 1.5 and 4.0 mm is applied in the form of a granular clay layer and is joined with the support plate or the intermediate layer by pressing at a pressure between 200 and 500 N/cm^2.

18. Process according to Claim 14, characterised in that for the purpose of preparing the formation of the ceramic mechanically protective layer, a clay layer optionally containing flux and/or other additives is applied onto a pre-pressed layer of the granulate of exfoliated vermiculite mixed with the binder, which layer

later forms the base layer (1'), that this raw composite structure is then hot-pressed while hardening the binder of the base layer, that the resulting raw composite plate is optionally brought by dividing into the predetermined plate format and that it is finally heat-treated at temperatures higher than 800°C.

19. Process according to Claim 18, characterised in that the clay layer is applied in the form of a granular clay layer, and is converted into a substantially compact clay layer during subsequent hot-pressing of the raw composite structure.

20. Process according to one of Claims 14 to 19, characterised in that the support plate (5,7,9), the support plate (1) joined with the intermediate layer (2) and the clay layer (3) or the raw composite plate is glazed or provided on its surface with a glass powder frit layer and baked at temperatures higher than 800°C or heat-treated at temperatures higher than 800°C, additionally glazed or provided on its surface with a glass power frit layer and subjected to another glaze baking operation.

21. Use of a plate according to one of Claims 1 to 13, or a plate produced by a process according to one of Claims 14 to 20, characterised in that it is used as a cladding plate with reduced sound reflection in or on buildings for the cladding of ceilings or walls.

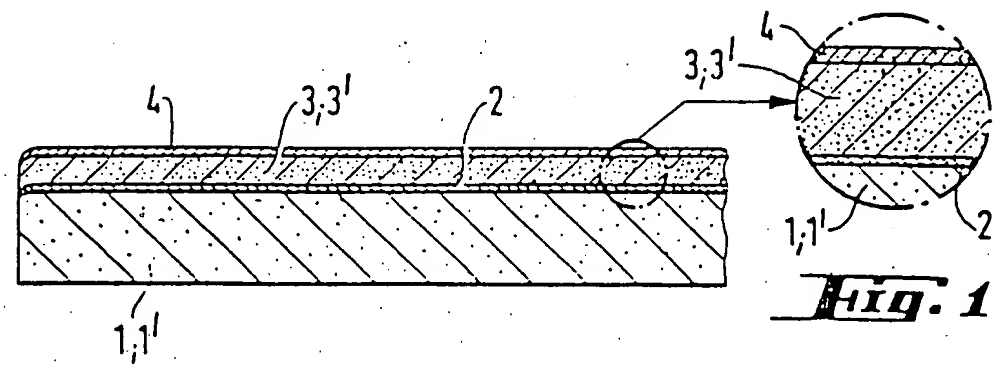

Fig. 1

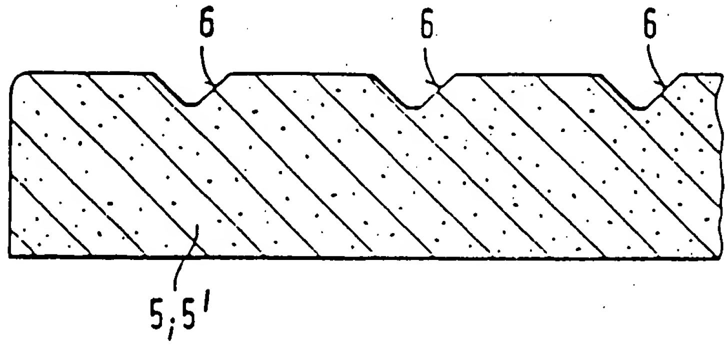

Fig. 2

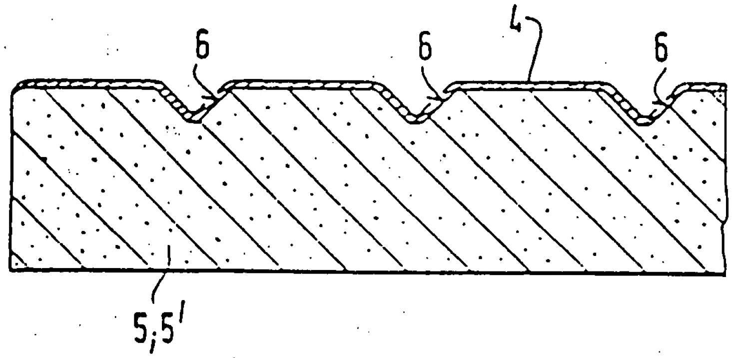

Fig. 3

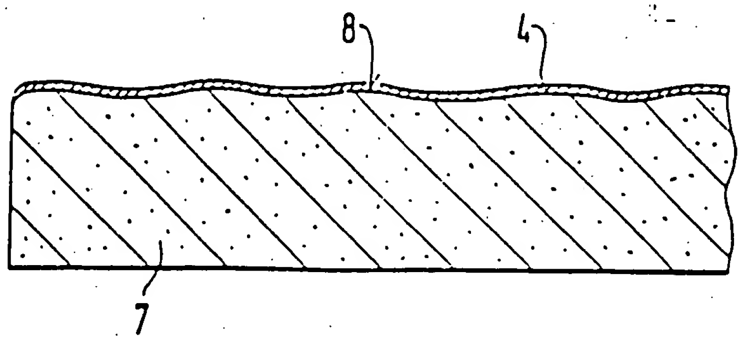

Fig. 4

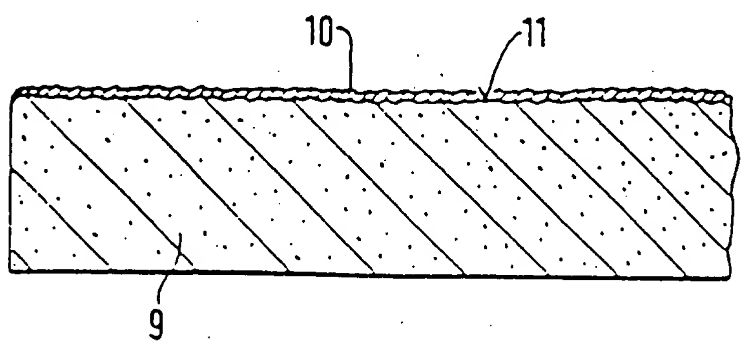

Fig. 5